

Citation for published version:

Tomlinson, PR & Branston, JR 2014, 'The demand for UK beer: Estimates of the long-run on- and off-trade beer price elasticities', *Applied Economics Letters*, vol. 21, no. 3, pp. 209-214.
<https://doi.org/10.1080/13504851.2013.848022>

DOI:

[10.1080/13504851.2013.848022](https://doi.org/10.1080/13504851.2013.848022)

Publication date:

2014

Document Version

Peer reviewed version

[Link to publication](#)

University of Bath

Alternative formats

If you require this document in an alternative format, please contact:
openaccess@bath.ac.uk

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

The decline of the British Pint: Estimates of the long run on and off-trade beer price elasticities

P. R. Tomlinson*

Centre for Governance and Regulation, School of Management, University of Bath

J. Robert Branston

Centre for Governance and Regulation, School of Management, University of Bath

*Corresponding Author:

School of Management
University of Bath
Bath
BA2 7AY
United Kingdom

Email: P.R.Tomlinson@bath.ac.uk
Tel: +44 (0)1225 383798

February 2013

Abstract

Over the last 30 years, UK beer sales have been falling while the market itself has experienced a dynamic shift from on-trade to off-trade sales. This paper provides estimates of the long run price, cross price and income elasticities for both on and off-trade beer consumption. The results shed light on the changing UK beer market, while also having different implications for imposing beer excise duties and the debate on a minimum price per unit for alcohol.

JEL Classification: D12, L16, L66

1. Introduction

Over the last 30 years, UK Beer consumption has fallen from 137.6 litres to 89.2 litres per capita (based on over 15 years of age). During the same period there has also been a changing dynamic within the beer market, with the proportion of sales of on-trade beer – commonly referred to as draught beer – falling from 86.5% of total beer sales in 1982 to 51.7% in 2010; there has been a concomitant rise in off-trade beer sales. This has had a significant impact upon the traditional British public house (the pub), which has predominantly relied upon beer sales; approximately 12 pubs close in the UK every week. One of the main reasons for this shift is changing relative prices; while the price per litre of on-trade beer has risen by 60% in real terms since 1982, the real price of off-trade beer has fallen by 15% (all data from the BBPA, 2012). This partly reflects rising UK excise duties which disproportionately affect on-trade beer prices, whereas the fall in the off-trade price is largely a consequence of heavy discounting of beer products by supermarkets, which utilise beer as a ‘loss leader’ (House of Commons Library, 2013)¹.

In this paper we estimate the long run price, cross price and income elasticities for both on and off-trade UK beer consumption. The few previous studies of alcohol consumption have tended to focus upon analysing aggregated alcohol sales across all beverages (e.g. McGuinness, 1980) or brand-level elasticities within the beer market (e.g. Pinske & Slade, 2004; Slade, 2004). No prior study has estimated specific elasticities for on and off-trade alcohol consumption, making this a potentially important contribution that sheds light on the changing dynamic within the UK beer market. The findings will have particular implications for the future imposition of UK excise duties on on-trade beer and with regard to recent proposals to impose a minimum price per unit on alcohol. The latter proposal is designed to reduce so-called ‘binge drinking’ and will largely affect off-trade sales, where alcohol prices have been heavily discounted (Purshouse *et.al*, 2010; Meir *et.al*, 2009). Finally, the approach may also hold insights for investigating other markets where products are offered for on and off-site consumption (e.g. ‘take out meals’ versus ‘bistro dining’) or through different mediums (e.g. music purchases).

2. Empirical Specification

2.1 The basic model

We are primarily interested in estimating the long run price and cross price elasticities for UK on and off-trade beer consumption (per capita), over the period 1982-2010. The model is a standard demand function, largely following McGuinness (1980) and is denoted in log form:

For on-trade beer consumption:

$$\ln Q_t^{on} = \beta_1 \ln A_t + \beta_2 \ln Y_t + \beta_3 \ln P_t^{on} + \beta_4 \ln P_t^{off} \quad (1a)$$

¹ UK excise levies on beer are nine times higher than in France, and 13 times more than in Germany, raising protests among pub landlords and the BBPA (BBPA, 2012, HCL, 2013).

and for off-trade beer consumption:

$$\ln Q_t^{off} = \beta_1 \ln A_t + \beta_2 \ln Y_t + \beta_3 \ln P_t^{on} + \beta_4 \ln P_t^{off} \quad (1b)$$

where Q_t^{on} and Q_t^{off} represent litres of beer consumed (per capita) per annum from on-trade and off-trade beer premises respectively; the per capita data representing all UK adults aged 15 and over. This captures the whole population that are legally entitled to purchase alcohol (age 18 plus), and those just below the legal age, who are also likely to consume alcohol purchased (possibly illegally) on their behalf. Both P_t^{on} and P_t^{off} represent the prices of on-trade and off-trade beer, deflated by the Retail Price Index (RPI). As with the data for beer consumption, the price data was obtained from the British Beer and Pub Association (BBPA) Statistical Handbook (2012). The inclusion of both prices in each model allows for the calculation of own-price and cross-price elasticities for both on-trade and off-trade beer demand. The control variables include A_t , which represents real advertising expenditure per capita on the promotion of beer sales. The data for this was purchased from Neilson IAG Research, and it represents the total advertising expenditure on beer with no breakdown between on and off-trade marketing. Such a break-down was not available and would be artificial given that advertising for a specific brand can impact both types of sales. Finally, Y_t denotes real disposable household income, data for which is published by the UK Office for National Statistics.

2.2 Empirical Analysis

Time series plots of the natural logs of both the dependent and independent variables are provided in Figures A1-A6 and are indicative of univariate non-stationarity in the data. Formal testing of the stationarity of the data is undertaken using augmented Dickey-Fuller (ADF) tests for the presence of unit roots, employing a constant and a trend in the levels regression and a constant in the first difference regression (Dickey and Fuller, 1979). The results are presented in Table 1, which confirm that each data series is non-stationary and is I(1).

INSERT TABLE 1 HERE

To avoid problems of spurious regression with time series data, co-integration analysis is applied utilising a Vector Error Correction Model (VECM). This takes the standard form:

$$\Delta Z_t = \sum_{j=1}^{k-1} \Gamma_j \Delta Z_{t-j} + \Phi D_t + \varepsilon_t \quad (t=1 \dots T) \quad (2).$$

where for on-trade Beer consumption, the vector Z_t^1 is given by $(Q_t^{on}, A_t, Y_t, P_t^{on}, P_t^{off})$ and for off-trade beer consumption, the vector Z_t^2 is given by $(Q_t^{off}, A_t, Y_t, P_t^{on}, P_t^{off})$, each with a known lag structure of k , with Δ denoting first differences and ε_t assumed to have the normal

Gaussian properties. The terms $\prod Z_{t-1}$ and $\sum \Gamma_j \Delta Z_{t-j}$ represent the vector autoregressive components in levels and in error correction components in first differences, respectively. The approach estimates Equation (2) subject to the hypothesis that $\prod = \alpha\beta'$ and has reduced rank $0 < r < K$, where α and β' are both $K \times r$ matrices of rank r . The r linear combinations of Z_t , the co-integrating vectors $B'Z_t$, are interpreted as deviations from long-run equilibrium, while α indicates the speed of adjustment (the error correction term). Higher values of α (which lies between 0 and 1) suggest a faster convergence towards long run equilibrium. $\Gamma_j, \dots, \Gamma_{k-1}$ are $K \times K$ matrices of parameters depicting short-run adjustments among the variables across K equations at the k^{th} lag. Finally, the term ΦD_t allows for a deterministic component within the data.

Following Johansen (1988) and Johansen and Juselius (1990), the first step is to specify the lag structure. For both Z^1 and Z^2 , this was done by considering the Akaike Information criterion (AIC), the Schwarz-Bayesian criterion (SBC) and the Hannan-Quinn information criterion (HQ), with the results reported in Table (2a and b). These suggested that the optimal lag structure is $k = 1$, which was utilised in the Maximum Likelihood Estimation in testing for co-integration². The results of this estimation are given in Table 3 (a and b) for both on-trade (Z^1) and off-trade (Z^2) beer consumption. For each system, both the Trace and the Maximum Eigen value statistics reject the null hypothesis of no co-integration. In both cases, however, the test statistics suggest evidence of the existence of one co-integrating vector. Given this, a Vector Error Correction model was then estimated for each case, again with $k=1$, and the results presented in Table (4).

INSERT TABLES 2 to 4 HERE

3. Discussion

Both models in Table (4) appear to perform reasonably well, with relatively high explanatory power. Diagnostic tests for residual autocorrelation, heteroskedasticity and normality appear to suggest the models are each well specified. In addition, each of the short-run adjustment co-efficients has the correct negative sign and lies between 0 and 1. Moreover, the value of the adjustment co-efficient on the dependent variable suggests that significant deviations from the long run will move relatively slowly towards long run equilibrium; approximately 4 years in the case of on-trade sales, and just under 3 years for off-trade sales (Column 1a and 1b, Table 4).

In each model, the coefficient estimates provide the long run own price, cross-price, advertising and income elasticities for on and off trade beer consumption (Table 4). Both the own price elasticities for on and off-trade beer are price elastic, at -1.68 and -1.60 respectively, suggesting UK beer drinkers are clearly sensitive to significant price hikes and adjust their consumption accordingly. Moreover, the cross-price elasticity between on and

² In Table 2b, the AIC statistic suggests that the lag structure for off-trade beer consumption is 2. However, this is highly marginal, and both the HQ and SBC suggest $k = 1$, which is chosen.

off-trade beer sales is estimated as being between 1.14 and 1.45, which implies that on and off-trade sales are close substitutes. Taken together, these results are consistent with the story of falling on-trade demand (and rising real beer prices) and rising off-trade sales (and falling real beer prices) outlined earlier. In addition, the advertising elasticity of demand is also highly significant but in each case inelastic, with the inferences being different in each model. It appears that real total advertising expenditure (per capita) on beer raises off-trade sales, but reduces on-trade sales; in each case a 10% rise in Advertising expenditure raises (reduces) by approximately 2%. Again, this is consistent with the changing dynamics of beer sales in the UK, with advertising being pro-cyclical in terms of the purchase venue. Indeed, while beer advertising is largely generic there is casual observation that the content of beer marketing has increasingly been geared towards promoting off-trade sales (HCL, 2013).

The income elasticity of demand is negative in each model, but only significant for off-trade sales. In this case, the estimate is -1.7 suggesting that off-trade consumption is a 'highly inferior product'. With overall beer sales falling, it is highly likely that rising incomes are leading beer drinkers to switch to more expensive beverages with a higher alcoholic content. Indeed, between 1982 and 2010, the annual consumption of pure (100%) alcohol content (in drinks) per capita rose from 8.8 to 10.2 litres per head, with the increase largely due to higher consumption of cider (total consumption rose from 6.5 to 18.3 litres per head) and wine (rising from 10.9 to 25.9 litres per head). Spirit consumption has also risen slightly from 2 to 2.2 litres per head (BBPA, 2012). Future research might further explore the issue of consumer switching to alternate beverages, by including the prices of other alcoholic drinks in the model specifications. This will require new comparative data for both the on and off trade prices of other alcoholic drinks, which is not currently available.

Finally, an issue arises as to the inclusion of a measure of the 'availability' of alcohol in our specifications. Unfortunately, the obvious proxy candidate - the number of on and off-trade licensed premises (McGuinness, 1980) - is no longer appropriate³. Since the late 1980s (and from 1994 for Sunday licenses) UK alcohol licensing hours have been liberalised with licensed premises having greater freedom of choice in terms of opening hours. It is 'total opening hours' which now best captures 'availability', but at present no such data is published. As such data becomes available, this measure might be utilised in future studies.

4. Concluding Comments

Both the data on UK beer consumption and the estimated new price and cross price elasticities for on and off-trade beer sales reflect falling overall beer sales, and also the changing dynamic within the UK beer market. Over the last 30 years, UK beer has increasingly been sold through off-trade outlets; the proportion of on and off trade sales is

³ Published data on licensed premises is sporadic and incomplete for the period 1982-2010. The total number of on-licence premises in the UK rose from approximately 77,840 in 1982 to 116,937, which was largely accounted for by a significant rise in hotel licenses and wine bars. Over the same period the total number of public houses – where predominantly on-trade beer is sold – fell from approximately 67,800 (in 1982) to 50,395 in 2011. In contrast, off-licences have risen from approximately 39,600 to 49,129, although off-licences per capita (15 years of age and over), has marginally fallen from 1188 persons (per off-licence) to 1054 (BBPA, 2012).

now almost 50:50. This has undoubtedly contributed to the demise of the traditional UK public house. Our estimated price elasticities also have further implications, most notably for the efficacy of UK customs and excise duties for on-trade draught beer and the imposition of a minimum price per unit of alcohol. In the first instance, further duty levies on draught beer to raise tax revenue are likely to be counter-productive, since long run beer demand is price elastic. On the other hand, proposed moves to introduce a minimum price per unit of alcohol to discourage 'binge drinking' and which will largely affect off-license trade might be effective (at least in the case of beer).

5. References

British Beer and Pub Association (2012) *Statistical Handbook* London: BBPA

House of Commons Library (2013) 'Beer Taxation and the Pub Trade', SN 1373, *Business and Transport Section*. London: Houses of Parliament

Johansen, S (1988) 'Statistical analysis of cointegration vectors', *Journal of Economic Dynamics and Control*, 12: 231-254

Johansen, S & Juselius, K (1990) 'Maximum Likelihood estimation and inference on cointegration – with applications to the demand for money', *Oxford Bulletin of Economics and Statistics*, 52, 169-210.

McGuinness, T (1980) 'An econometric analysis of total demand for alcoholic beverages in the UK, 1956-1975', *Journal of Industrial Economics*, Vol XXIX, No. 1 (September), 85-109.

Meir, P.S., Purshouse, R.C & Brennan, A (2009) 'Policy options for alcohol price regulation: the importance of modelling population heterogeneity', *Addiction*, 105, 383-393

Purshouse, R.C, Meir, P.S, Brennan, A, Taylor, K.B & Raftery, R (2010) 'Estimated effect of alcohol pricing policies on health and health economic outcomes in England: an epidemiological model', *The Lancet*, Vol 375, 1357-1324

Neilson IAG Research (2012) *UK Advertising expenditure on Beer*, London: Neilson IAG

Pinkse, J. & Slade, M.E. (2004) 'Mergers, brand competition, and the price of a pint' *European Economic Review*, 48, 617-643.

Slade, M.E. (2004) 'Market Power and Joint Dominance in U.K. Brewing' *The Journal of Industrial Economics*, 52(1), 133-163.

UK National Office of Statistics (2013) *Real Personal Disposable Income data* London: www.statistics.gov.uk/ (accessed, 15/1/2013)

Table (1)**Time Period 1982-2010****Augmented Dickey-Fuller Tests (t-statistics)** H_0 : Series has a unit root (non-stationary) H_1 : Series does not have a unit root (stationary)

Variable	Level	First Difference	Order of Integration
<i>Log of Beer Consumption Litres per capita (on-trade)</i>	-0.998617	-2.889309*	I(1)
<i>Log of Beer Consumption Litres per capita (off-trade)</i>	-0.392630	-4.190179**	I(1)
<i>Log of Real Advertising Expenditure per capita</i>	0.962899	-4.712937**	I(1)
<i>Log of Real Income per capita</i>	0.661293	-3.060905**	I(1)
<i>Log of On Trade Beer Prices (constant prices)</i>	-1.032951	-3.937804**	I(1)
<i>Log of Off Trade Beer Prices (constant prices)</i>	-2.304580	-3.463233**	I(1)

*(**) denotes significance at the 5% (1%) levels respectively (based upon MacKinnon (1996) p-values).

Table 2a**On-Trade Beer Consumption: VAR lag order selection criteria**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	170.6171	NA	5.01e-12	-11.82979	-11.59190	-11.75706
1	358.8128	295.7361*	4.49e-17*	-23.48663*	-22.05926*	-23.05027*
2	380.5474	26.39203	6.85e-17	-23.25338	-20.63655	-22.45339
3	403.7949	19.92643	1.36e-16	-23.12821	-19.32191	-21.96458

* indicates lag order selected by the criterion

Table 2b**Off-Trade Beer Consumption: VAR lag order selection criteria**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	170.8204	NA	4.94e-12	-11.84432	-11.60642	-11.77159
1	347.3349	277.3798*	1.02e-16*	-22.66678	-21.23941*	-22.23042*
2	372.5893	30.66611	1.21e-16	-22.68495*	-20.06812	-21.88496
3	383.0111	8.932990	5.99e-16	-21.64365	-17.83735	-20.48003

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

**Table 3a: On-Trade UK Beer Consumption (litres per capita (15 years and over)):
Johansen Co-integration Test**

Hypothesized No. of Co-integrating vectors	Eigenvalue	Trace Statistic	Max-Eigen Value Statistic
$H_0: r = 0$	0.808006	98.35218**	47.85845**
$H_0: r \leq 1$	0.593723	50.49373*	26.12089
$H_0: r \leq 2$	0.440614	24.37284	16.84652
$H_0: r \leq 3$	0.220979	7.526313	7.241796
$H_0: r \leq 4$	0.009763	0.284517	0.284517

*(**) denotes significance at the 5% (1%) levels respectively (based upon MacKinnon-Haug-Michelis (1999) p-values).

**Table 3b: Off-Trade UK Beer Consumption (litres per capita (15 years and over)):
Johansen Co-integration Test**

Hypothesized No. of Co-integrating vectors	Eigenvalue	Trace Statistic	Max-Eigen Value Statistic
$H_0: r = 0$	0.903083	103.7207**	60.68140**
$H_0: r \leq 1$	0.569427	43.03934	21.90860
$H_0: r \leq 2$	0.372566	21.13073	12.11903
$H_0: r \leq 3$	0.187228	9.011704	5.389907
$H_0: r \leq 4$	0.130033	3.621798	3.621798

*(**) denotes significance at the 5% (1%) levels respectively (based upon MacKinnon-Haug-Michelis (1999) p-values).

Table 4

Vector Error Correction Estimates 1982-2010	On-Trade Beer Consumption (a)	Off-Trade Beer Consumption (b)
<i>Long Run Coefficients</i>		
$\ln A$	-0.2066*** (0.08970)	0.1851*** (0.04421)
$\ln Y$	-0.1168 (0.23604)	-1.7025*** (0.12316)
$\ln P_{on}$	-1.6855*** (0.45021)	1.1443*** (0.22109)
$\ln P_{off}$	1.4535*** (0.26116)	-1.6016*** (0.14211)
<i>Short Run Adjustment Coefficients</i>		
$\Delta \ln QB_{on}$	-0.2345*** (0.02973)	
$\Delta \ln QB_{off}$		-0.3842*** (0.14176)
$\Delta \ln A$	-0.2578 (0.24051)	-0.6698 (0.52306)
$\Delta \ln Y$	-0.1226*** (0.02147)	-0.1307*** (0.05512)
$\Delta \ln P_{on}$	-0.0301 (0.03002)	-0.09670 (0.07228)
$\Delta \ln P_{off}$	-0.1016** (0.04933)	-0.0204 (0.11438)
R-squared	0.697268	0.553451
F-statistic	62.18776	3.924757
Log likelihood	77.93060	54.58638
Akaike AIC	-5.236593	-3.660490
Schwarz SC	-5.142297	-3.321772
LM Stat (1)	21.80611	8.204276
Kurtosis (Joint) (df 5)	1.302592	1.060033
Jarque-Bera (Joint) (df 10)	5.936265	4.072724
Heteroskedasticity (Joint)	25.65637	175.3421

(*) denotes significance at the 5% (1%) levels respectively (t statistics)

Appendix A1 to A6

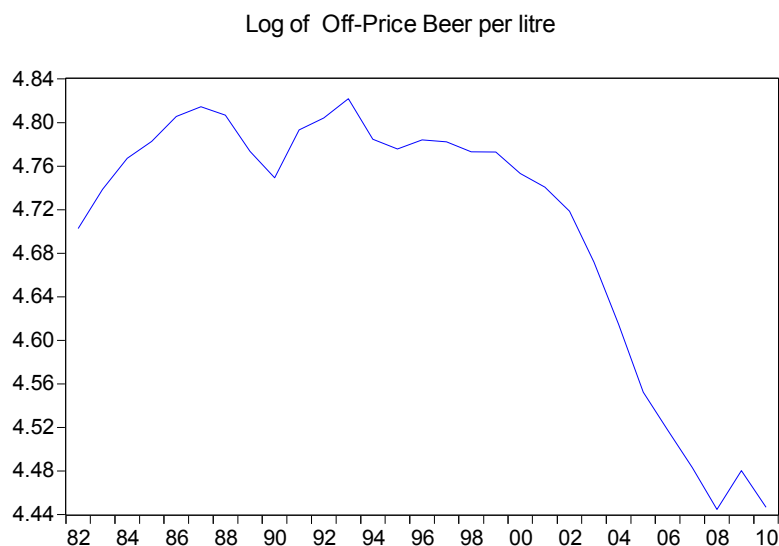
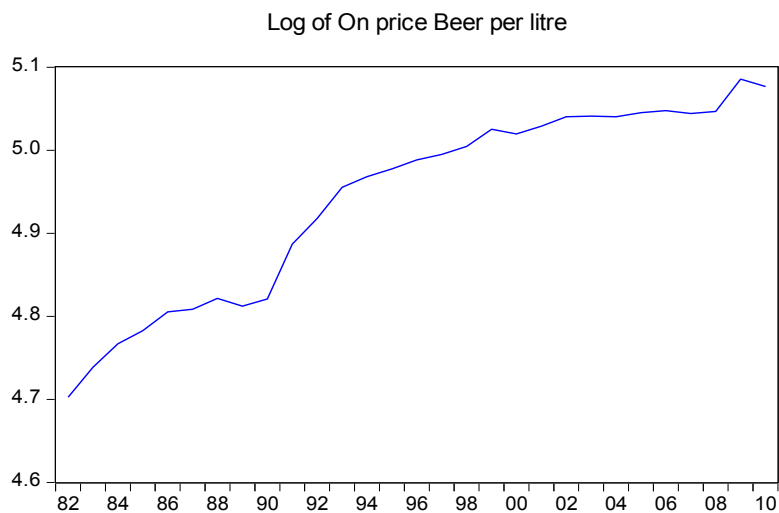
Data Sources:

Beer Consumption (on and off-trade) Litres per capita (aged 15 and over) 1982-2010; BBPA (2012) Statistical Handbook

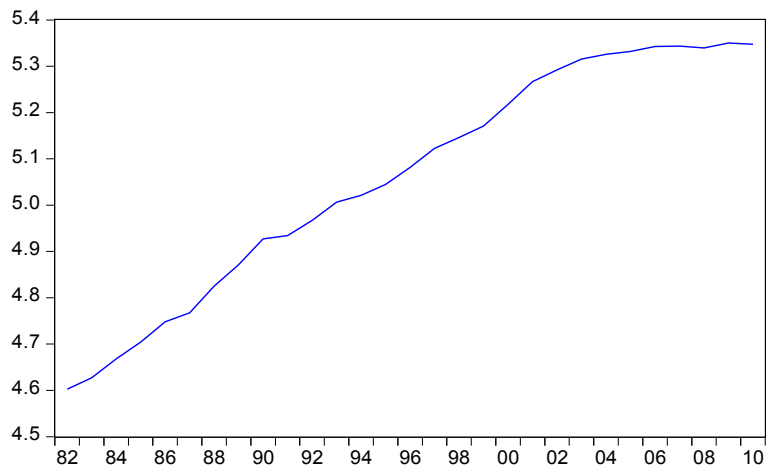
Real Price of On-trade and Off-trade Beer 1982-2010, deflated by the UK RPI; BBPA (2012) Statistical Handbook. (Index 1982 = 100).

Real Disposable Income, 1982-2010 (1982 = 100); *UK National Office of Statistics (2013)*

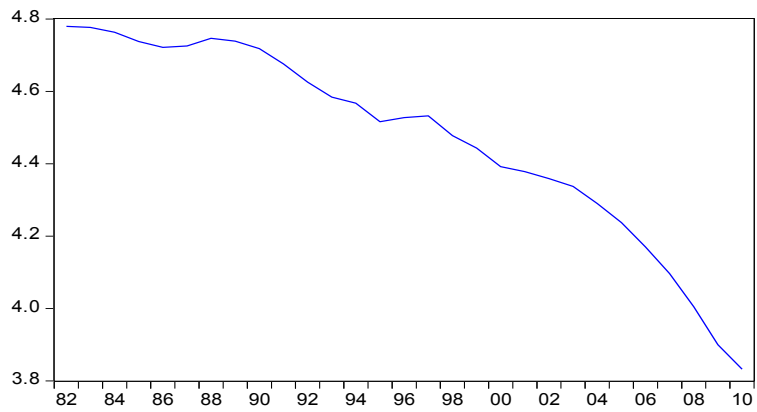
Real Advertising expenditure on Beer, 1982-2010 (1982 = 100), deflated by the UK RPI; Neilson IAG Research (2012)



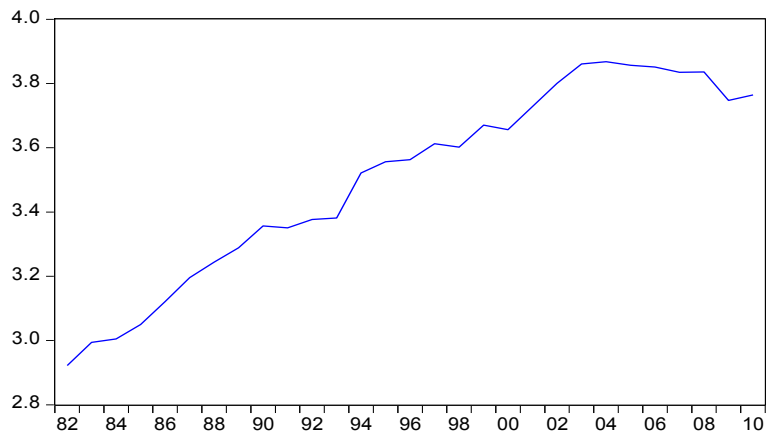
Log of Real Disposable Income



Log of On-trade Beer Consumption 1982-2010



Log of Off-Trade Beer Consumption



Log of Real Advertising on Beer per capita

